



## REVIEW

# The feasibility of local anesthesia for the surgical treatment of umbilical hernia: a systematic review of the literature

A. P. Jairam<sup>1</sup> · R. Kaufmann<sup>1</sup> · F. Muysoms<sup>2</sup> · J. Jeekel<sup>3</sup> · J. F. Lange<sup>1</sup>

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## Abstract

**Background** Yearly approximately 4500 umbilical hernias are repaired in The Netherlands, mostly under general anesthesia. The use of local anesthesia has shown several advantages in groin hernia surgery. Local anesthesia might be useful in the treatment of umbilical hernia as well. However, convincing evidence is lacking. We have conducted a systematic review on safety, feasibility, and advantages of local anesthesia for umbilical hernia repair. **Methods** A systematic review was conducted according to the PRISMA guidelines. Outcome parameters were duration of surgery, surgical site infection, perioperative and postoperative complications, postoperative pain, hernia recurrence, time before discharge, and patient satisfaction. **Results** The systematic review resulted in nine included articles. Various anesthetic agents were used, varying from

short acting to longer acting agents. There was no consensus regarding the injection technique and no conversions to general anesthesia were described. The most common postoperative complication was surgical site infection, with an overall percentage of 3.4%. There were no postoperative deaths and no allergic reactions described for local anesthesia. The hernia recurrence rate varied from 2 to 7.4%. Almost 90% of umbilical hernia patients treated with local anesthesia were discharged within 24 h, compared with 47% of patients treated with general anesthesia. The overall patient satisfaction rate varied from 89 to 97%. **Conclusion** Local anesthesia for umbilical hernia seems safe and feasible. However, the advantages of local anesthesia are not sufficiently demonstrated, due to the heterogeneity of included studies. We, therefore, propose a randomized controlled trial comparing general versus local anesthesia for umbilical hernia repair.

✉ A. P. Jairam  
a.jairam@erasmusmc.nl

R. Kaufmann  
r.kaufmann@erasmusmc.nl

F. Muysoms  
filip.muysoms@gmail.com

J. Jeekel  
j.jeel@erasmusmc.nl

J. F. Lange  
j.lange@erasmusmc.nl

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## Introduction

Umbilical hernia is a common diagnosis in surgery [1, 2]. Approximately, 10% of all abdominal wall hernias are defined as umbilical hernia [3], and the prevalence of umbilical hernia in the adult population is 2% [4]. The European Hernia Society defines a primary umbilical hernia as a ventral hernia present at birth or developed spontaneously without trauma to the abdominal wall as the cause of the hernia and with its center at the umbilicus [5]. Each year, approximately 4500 umbilical hernias are repaired in the Netherlands and most of these patients are operated under general anesthesia.

- <sup>1</sup> Department of Surgery, Erasmus University Medical Center Rotterdam, Room Z-835, 3000 CA Rotterdam, The Netherlands
- <sup>2</sup> Department of Surgery, Algemeen Ziekenhuis Maria Middelaars, Kortrijksesteenweg 1026, 9000 Ghent, Belgium
- <sup>3</sup> Department of Neuroscience, Erasmus University Medical Center, Rotterdam, 3000 CA Rotterdam, The Netherlands

Worldwide, ever more patients undergo ambulatory hernia surgery performed under local anesthesia [6]. Local anesthesia in the treatment for groin hernias has been already thoroughly investigated. Studies showed the superiority of local anesthesia for open groin hernia repair than general anesthesia or spinal anesthesia [7–13]. However, only 7% of Dutch surgeons uses local anesthesia in Lichtenstein repair [13]. This is surprising, since the use of local anesthesia could prevent complications related to general anesthesia. Possible advantages of the use of local anesthesia are less postoperative pain and extended postoperative analgesia, less perioperative and postoperative complications, early mobilization and, therefore, a shorter duration of hospital stay. Furthermore, use of local anesthesia could be more cost-effective than general anesthesia or spinal anesthesia, since there is no anesthesiologist needed and only less expensive local anesthetics are used [7, 13–16]. There is a lack of convincing literature on umbilical hernia repaired under local anesthesia [1]. We have conducted a systematic review of the literature on the safety, feasibility, and advantages of local anesthesia for the repair of umbilical hernia.

## Materials and methods

We conducted a systematic review following the PRISMA guidelines [17]. A systematic search was performed in MEDLINE, Embase, Web of Science, Scopus, PubMed Publisher, and the Cochrane Library.

The search strategy was prepared by the Biomedical Information Specialist of the Medical Library (Erasmus University Medical Center, Rotterdam, the Netherlands). A syntax with search terms was designed, which is available at Appendix 1.

Records identified were independently evaluated by two reviewers. All records were screened by title and abstract for eligibility, and the full text of eligible records was assessed. Studies were included into the analysis if they met the following inclusion criteria: adult patients with umbilical hernia or paraumbilical hernia, who were operated under local anesthesia with or without a control group operated with another type of anesthesia. Articles had to be written in Dutch, English or German, and randomized controlled trials, cohort studies and case series (with more than 5 patients) were included. Exclusion criteria were studies investigating local anesthesia for other types of hernia than umbilical hernias, laparoscopic surgery, and animal studies or in vitro experiments.

The following outcome measurements were assessed: postoperative pain, duration of surgery, surgical site infection, perioperative and postoperative complications, hernia recurrence, time before discharge, and patient

satisfaction. We also extracted the baseline study characteristics from all included studies: study design, study period, and year of publication. The quality of the studies was assessed on the Level of Evidence scale of the Oxford Centre for Evidence-based Medicine [18].

Both reviewers independently sampled the data in a standardized database. This database was set up in Microsoft Office Excel 2010. The data presented in this review were directly abstracted from the original articles. No statistical analyses were performed.

## Results

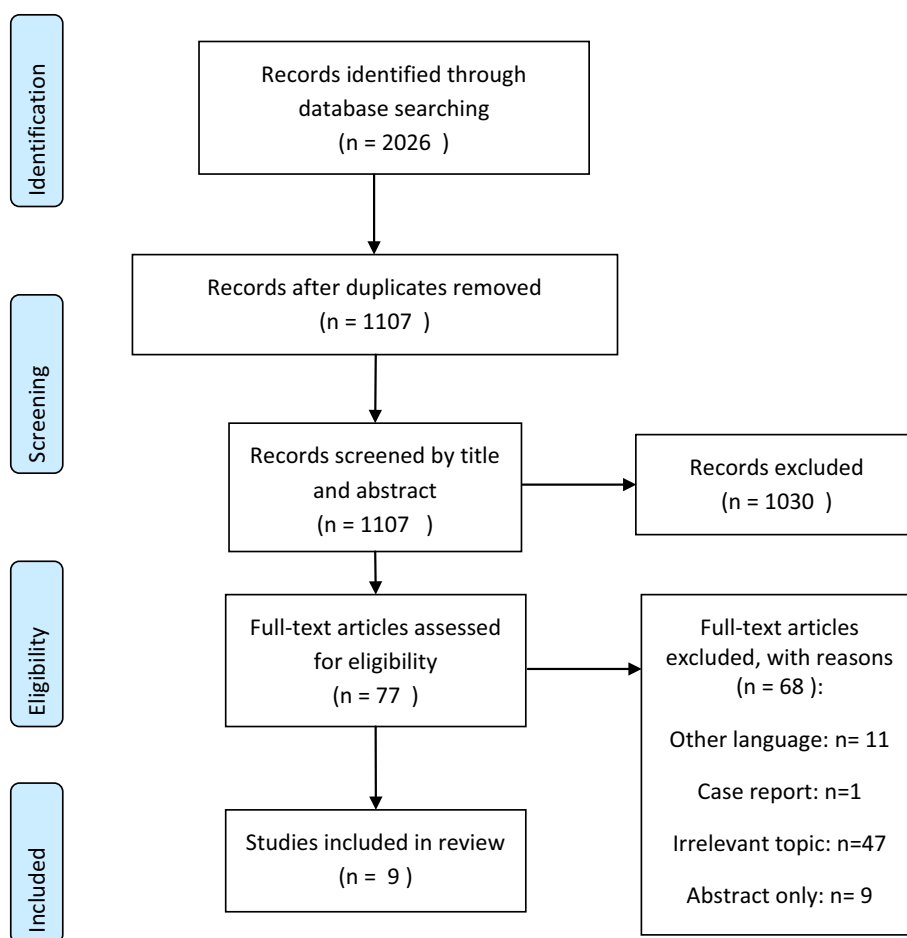
A total of 1107 articles were identified after the removal of duplicates. After screening of these records 77 articles were found eligible for further assessment. After assessment of the full text versions of these 77 articles, 9 articles were suitable for inclusion in this review. The reasons for exclusion were as follows: anesthesia or umbilical hernia were not well described and not the main subject, research was performed in children or animals, the article contained a case report, there was only an abstract available, or the article was written in another language than Dutch, English or German. The PRISMA flow diagram is shown in Fig. 1.

Of the nine included articles, six were prospective cohort studies, and three were retrospective cohort studies. No randomized study comparing local versus general anesthesia was found. All studies contained a Level of Evidence of 2B on the scale of the Oxford Centre for Evidence-based Medicine. Table 1 gives an overview of the articles we included for this review.

In this review, the following outcome parameters will be highlighted: anesthesia technique, postoperative pain, duration of surgery, surgical site infection, perioperative and postoperative complications, recurrence, time before discharge and patient satisfaction. The anesthesia technique was described to outline if there was any consensus regarding the injection technique and the type of anesthetics.

### Surgical technique

There were two studies in which a Mayo repair was performed, with the classical ‘vest over pants’ technique [19, 20]. Bennett et al. inserted a polypropylene soft mesh plug if the defect was <2 cm. In case the defect was >2 cm, a preperitoneal pocket was made and a polypropylene soft mesh was placed, with a 2 cm margin [14]. In the study of Kurzer et al. a cone polypropylene mesh was used for defects <3 cm, and a flat piece mesh for defects >3 cm [2]. Garcia et al. used 1 cm as a cutoff point for a primary suture, and ‘large’ hernias, as they stated,

**Fig. 1** Flow diagram search

received a polypropylene mesh [4]. Three articles did not mention which cutoff point they used to determine the use of primary sutures or a mesh, and in only one study umbilical hernia operations with meshes was performed [1, 3, 6, 19]. Dalenbäck et al. were the only authors who specified the type of surgical procedure for the type of anesthesia. A total of 162 patients underwent an umbilical hernia operation. Of the patients operated with a suture repair, 59% were operated under local anesthesia and 41% under general anesthesia. Of the patients receiving a mesh repair, 18% were operated under local anesthesia and 82% under general anesthesia.

### Anesthesia technique

There are various anesthesia techniques assessed in the studies. Only Acevedo and León described the use of local anesthesia without addition of a sedative [6]. Four other studies combined the use of local anesthesia with sedatives and another four studies used local anesthesia (without sedatives) or general anesthesia for their patient groups [1–4, 14, 19–21]. None of the authors randomized between local anesthesia and general anesthesia. Table 2 shows the

various types of anesthesia (local anesthesia or general anesthesia, local anesthesia with or without sedatives) and the different types of anesthetic drugs that were used. The anesthetic drugs varied from the short acting lidocaine and xylocaine to the longer acting agent bupivacaine. Bennett et al. were the only authors who described the injection technique, which was a field block technique: infiltration of the skin and rectus sheath around the umbilicus [14]. Kulacoglu et al. studied patients with umbilical hernia treated with local anesthesia. They stated there were no conversions to general anesthesia; all patients tolerated local anesthesia and there were no intraoperative anesthesia-related complications [1].

### Postoperative pain

One study made use of the Visual Analogue Scale (VAS) as a measurement scale to define ‘postoperative pain’. The authors included patients with different types of hernia and concluded that 79% of lean patients (BMI <30) had a VAS of <3, compared with 71.9% of the obese patients (BMI ≥30). This difference was statistically significant ( $p = 0.007$ ). In this study, no distinction was made

**Table 1** Study characteristics

Author	Study type	Year of publication	Total number of patients	Level of evidence	Type of hernia	Outcome measurements
Acevedo and Léon	Prospective cohort study	2010	2031 (326 umbilical hernia)	2B	Inguinofemoral, epigastric, umbilical, incisional	Perioperative pain, complications
Bennett et al.	Prospective cohort study	2013	63	2B	Paraumbilical	Duration of surgery, patient satisfaction
Dalenbäck et al.	Retrospective cohort study	2013	162	2B	Umbilical	Recurrence, pain, complications
Garcia-Urena et al.	Prospective cohort study	2000	157	2B	Umbilical, epigastric	Complications, time to discharge
Kulacoglu et al.	Prospective cohort study	2012	100	2B	Umbilical	Pain (VAS), time to discharge, complications, recurrences
Kurzer et al.	Prospective cohort study	2004	54	2B	Umbilical	Pain, complications
Menon and Brown	Retrospective cohort study	2003	32	2B	Umbilical	Duration of surgery, complications, recurrence
Sinha and Keith	Retrospective cohort study	2004	34	2B	Umbilical	Duration of surgery, time to discharge, complications, recurrences
Stabilini et al.	Prospective cohort study	2009	69	2B	Umbilical, epigastric	Time to discharge, recurrence, complications

**Table 2** Anesthesia techniques: the different types of anesthesia used and types of local anesthetics

Author	LA	LA + sedation	LA or GA
Acevedo and Léon	<b>Lidocaine 0.5%</b>	Not applicable	Not applicable
Bennett et al.	Not applicable	Not applicable	<b>GA: not described</b> <b>LA: xylocaine 2%, bupivacaine 0.5%</b>
Dalenback et al.	Not applicable	Not applicable	<b>GA: not described</b> <b>LA: not described</b>
Garcia et al.	Not applicable	<b>Lidocaine 1% + midazolam</b>	Not applicable
Kulacoglu et al.	Not applicable	<b>Lidocaine, bupivacaine 0.5% + midazolam and fentanyl</b>	Not applicable
Kurzer et al.	Not applicable	<b>Bupivacaine 0.25% + midazolam</b>	Not applicable
Menon and Brown	Not applicable	<b>Xylocaine 1% + bupivacaine 0.5% + midazolam</b>	Not applicable
Sinha and Keith	Not applicable	Not applicable	<b>GA: not described</b> <b>LA: xylocaine 1%</b>
Stabilini et al.	Not applicable	Not applicable	<b>GA: not described</b> <b>LA: mepivacaine</b>

between VAS scores per hernia type. It was neither described what VAS score patients had who were operated under local anesthesia [6].

Two other studies used terminology like ‘mild, moderate or severe’ and ‘no severe postoperative pain’ to report pain [1, 2]. The authors did not mention which questionnaire or measurement scale was used for these statements.

### Duration of surgery

Six authors investigated the duration of surgery, which ranged from 24 to 78 min [1, 4, 6, 14, 20, 21]. Table 3

shows that Bennett et al. were the only authors making a distinction between local anesthesia and general anesthesia for this outcome parameter. This study showed that the use of local anesthesia for paraumbilical hernia could lead to a shorter duration of surgery than the use of general anesthesia ( $p$  value <0.0003). However, patients with a lower BMI were more frequently operated under local anesthesia. When BMI was categorized to see if there was any difference between patients with a BMI less or more than 25, and less or more than 30 (obese), there was no difference found in the length of the procedure. [14]. Kulacoglu et al. and Menon and Brown all included patients with umbilical

**Table 3** Duration of surgery

Author	N	Hernia type	Anesthesia	Duration of surgery, mean (min)
Acevedo and León	2031	Inguinofemoral, epigastric, umbilical, incisional	LA	Lean 62 ( $\pm 8.6$ ) min Obese 78 ( $\pm 11.7$ ) min, $p < 0.001$
Bennett et al.	63	Paraumbilical	LA + GA	LA 24 (17.5–30) GA 35 (27–45), $p < 0.0003$
Garcia et al.	157	Umbilical, epigastric	LA	49.7
Kulacoglu et al.	100	Umbilical	LA	69 (25–150)
Menon and Brown	32	Umbilical	LA	30 (22–40)
Sinha and Keith	34	Umbilical	LA + GA	50 (40–108)

hernia treated with local anesthesia alone. Kulacoglu et al. showed that the mean operative time was 69 min (range 25–150 min), but in the patient group of Menon and Brown, the duration of surgery was significantly shorter with a mean operative time of 30 min (range 22–40 min) [1, 20].

### Surgical site infection

Surgical site infection (SSI) is a common postoperative complication and one of the most commonly described outcome parameters. The overall percentage of SSI was 3.4% (15/431), and ranged from 1% to 12.9% [1, 2, 4, 19, 20]. Three studies described that SSI responded well to conservative wound care or oral antibiotics, and no further treatment was required. Two remaining studies did not describe the treatment for SSI. Besides Acevedo and León, none of the authors described in which patient group SSI occurred [1, 2, 4, 19, 20]. Acevedo and León noted that there was a significantly higher rate of SSI in obese patients (BMI  $>30$ ) than in non-obese patients, respectively, 2.1 and 0.7% ( $p < 0.023$ ). None of the articles specified the SSI rate per hernia or anesthesia type, nor was it described if SSIs were more frequently seen in patients treated with a mesh.

### Other postoperative complications

The most frequent postoperative complications were seromas, with a range of 3–8.9%, and an overall percentage of 4.8%. All seromas either resolved spontaneously or were successfully treated with drainage [1, 3, 4, 21]. The second most frequent postoperative complication were hematomas (1%) [1, 3, 4]. There was one patient who suffered from postoperative bleeding and one other patient who suffered from intestinal obstruction. Both patients needed emergency surgery to resolve these complications [19]. Postoperatively, there were two patients suffering from allergic skin changes due to a plaster allergy [1]. Finally, there was one 86-year old patient operated under general anesthesia,

who experienced episodes of confusion and dizziness postoperatively. Therefore, a prolonged hospital stay of 12 days was needed [21]. In total, 3 patients passed away after surgery, respectively, due to the following causes: liver cirrhosis, cerebral infarction and chronic renal failure. All causes were not related to the operation [3]. No peri-operative complications were described. None of the articles made a comparison between type of anesthesia.

### Recurrence

Seven studies described hernia recurrence rate as an outcome measurement [1–4, 19–21]. In three of these studies, no recurrences occurred [1, 2, 20]. The mean follow-up in these studies was 17 months (5–41), 43 months (28–67), and 70 months (27–142). The remaining four articles measured a recurrence rate ranging from 2 to 7.4% [3, 4, 19, 21]. These four studies did not mention which patients presented with a recurrence. Dalenbäck et al. were the only authors who included umbilical hernia patients alone. They made a distinction in recurrence rates between patients operated under general anesthesia and patients operated under local anesthesia. The authors found two recurrences (out of 144 patients) in the general anesthesia group and five recurrences (out of 144 patients) in the local anesthesia group. No statistical comparison was made between these two groups [19]. The studies did not describe how the recurrence was diagnosed: with physical examination only or with the addition of radiological examination.

### Duration of postoperative stay

The mean duration of postoperative stay at the hospital varied from 2 hours to almost 2 days [1, 3, 4, 20, 21]. Table 4 gives an overview of the mean time before discharge. Kulacoglu et al. showed that patients with umbilical hernia, operated under local anesthesia, stayed  $122 \pm 58$  min in hospital before discharge [1]. Sinha and

**Table 4** Time to discharge

Author	Type of anesthesia	Type of hernia	Time to discharge (mean)
Garcia et al.	Local anesthesia	Umbilical and epigastric hernia	7.2 h
Kulacoglu et al.	Local anesthesia	Umbilical hernia	122 min $\pm$ 58 min (45–420)
Menon and Brown	Local anesthesia	Umbilical hernia	Same day, discharge before 20:00 p.m.
Sinha and Keith	General or local anesthesia	Paraumbilical hernia	LA: 89% discharged <24 h GA: 47% discharged <24 h
Stabilini et al.	General or local anesthesia	Umbilical hernia and epigastric hernia	1.8 days (3 h–15 days)

Keith described that 89% of the patients in the local anesthesia group were discharged in less than 24 hours, compared with 47% of the patients in the general anesthesia group [21]. The other articles did not specify the duration of stay for the type of anesthesia or type of hernia. The longest mean duration of stay was 1.8 days (range 3 h–15 days) and was required due to severe associated diseases of the patients, emergency surgery for hernia strangulation and wound hematoma [3].

### Patient satisfaction

Five studies reported on patient satisfaction, which was reported to be good in 89% till 97% of patients. Different methods of measuring this outcome parameter were used. Acevedo and Léon defined patient satisfaction as good, if the VAS for patient satisfaction was >7 points on a 10 points scale, in combination with a positive answer to the question ‘would you recommend this kind of surgery to others?’ This was measured at the 1 week control [6]. Sinha and Keith stated that 97% of their patient population was satisfied, according to the definition of Reitter [21]. The remaining three authors did not describe which questionnaire was used to define and measure patient satisfaction [1, 14, 19]. Two authors specified the patient satisfaction with regard to the body mass index of the patient [6, 14]. None of the articles specified the patient satisfaction per hernia type or anesthesia type [1, 19, 21].

### Discussion

The data from this systematic review reveal that the use of local anesthesia in umbilical hernia repair led to a shorter duration of postoperative stay, and that repair of a paraumbilical hernia performed under local anesthesia leads to a shorter duration of surgery. The use of local anesthesia did not lead to perioperative complications, serious postoperative complications, allergic responses or anesthesia-related deaths.

Umbilical hernia is a common surgical problem [1, 2]. At this moment, data on umbilical hernia surgery under local anesthesia are only scarcely available. In contrast, groin hernias operated under local anesthesia are very well described in literature, and several studies have been performed [7, 10–13, 15, 22]. All these studies show the advantages of local anesthesia: less postoperative and general anesthesia-related complications, a shorter duration of surgery, less overnight admissions, less postoperative pain and no deaths. Van Veen et al. showed that significantly more urinary retentions occurred in patients undergoing Lichtenstein hernia repair under spinal anesthesia [7]. Furthermore, the conversion rate to general anesthesia was lower for patients operated under local anesthesia (2%) than patients operated under spinal anesthesia (10%) [15]. Nordin et al. also showed that local anesthesia has significant cost advantages compared to spinal anesthesia and general anesthesia [12]. We, therefore, performed a review of literature to investigate the safety and feasibility of the use of local anesthesia for umbilical hernia and to explore if there are any advantages to the use of local anesthesia for umbilical hernia.

We have performed a literature search and found no randomized controlled trials or other significant papers giving solid evidence for the use of local anesthesia as being superior in the treatment of umbilical hernias. Only a few small prospective or retrospective cohort studies were included in this review. The studies we included do not solely include umbilical hernias, and when the studies did include solely umbilical hernias, the authors did not describe their local anesthesia treatment well.

If we take a closer look at the included studies, a very high heterogeneity can be noticed. First of all; there is no consensus regarding the local anesthetic drug, and the technique to induce local anesthesia. The used local anesthetic drug varies from shorter acting lidocaine to the longer acting ropivacaine. The technique to inject is not discussed in most of the articles, one article mentioning the ‘field block’ as a way to induce local anesthesia. Some authors diluted their anesthetic with another type of anesthetic, others diluted it with saline or adrenaline. Amid



et al. described a simple step-by-step infiltration technique for inguinal hernia, which is adapted and followed in most of the studies using local anesthesia for inguinal hernia [7, 10, 13, 15, 23]. Furthermore, Amid et al. used a solution which consisted of 1% lidocaine, 1% bupivacaine and epinephrine, which is used by other authors as well [7, 15]. In local anesthesia of umbilical hernia, a standardized protocol is missing and should, therefore, be set up.

Pain is an important outcome measurement. However, not all studies describe perioperative or postoperative pain as an outcome measurement, and not all authors who do describe postoperative pain use the visual analog scale (VAS) to measure pain. Several studies regarding inguinal hernia have shown that postoperative pain in patients treated with local anesthesia is (significantly) lower compared to general anesthesia or spinal anesthesia [7, 15], but this outcome measurement is, despite of its importance, not thoroughly investigated for umbilical hernia. Due to this inconsistency, comparison of the studies is impossible.

Another essential outcome measurement is represented by postoperative complications. Surgical site infections and seromas are the most common complications. In the underlying studies, these complications either resolved spontaneously, were treated with drainage or antibiotics, and had no serious consequences for the patient. It is not clear if complications occurred more frequently among patients treated with local anesthesia, since the authors did not describe which patient developed a postoperative complication. There were no perioperative complications, nor any allergies against local anesthetics, or deaths described.

The hernia recurrence rate varied from 2 to 7.4%, with a higher percentage for patients who were treated with primary sutures. This is comparable with the available literature, which describes a recurrence rate of approximately 2% for mesh repair, rising up to 8% for suture repair [24, 25]. However, recently the cohort study of Christoffersen et al. showed that the total cumulated recurrence rate after primary repair was 10% for mesh repair and 21% for sutured repair after 55 months of follow-up ( $p = 0.001$ ) [26], which is a surprisingly high percentage. Dalenbäck et al. showed that the recurrence rate among umbilical hernia patients operated under local anesthesia was higher (5/144) than in patients operated under general anesthesia (2/144). However, since there was no statistical comparison made, no conclusions can be drawn.

The duration of surgery varied from 24 to 78 min and was for all studies, with one exception, not specified per type of hernia or type of anesthesia. Bennett et al. were the only authors who did specify the outcomes per anesthesia type and showed that patients with a paraumbilical hernia operated under local anesthesia had a shorter duration of surgery than patients operated under general anesthesia. However,

when BMI was categorized (more or less than BMI 25, and more or less than a BMI of 30), there were no differences found for duration of surgery. It can be concluded that BMI was a confounding factor, and patients who were operated under local anesthesia had more frequently a lower BMI.

Almost 90% of the patients operated with local anesthesia were discharged within 24 hours. This percentage rate is almost twice as high as patients operated under general anesthesia: 47% was discharged within 24 hours. This is comparable with the available literature for groin hernias. Studies show a significantly shorter in hospital stay as well, and significantly less postoperative overnight admissions [7, 15]. There is no study comparing the difference in discharge time for local anesthesia and general anesthesia in umbilical hernia patients.

In our opinion, patients that would be eligible to undergo umbilical hernia repair under local anesthesia are cooperative patients with a low to normal BMI without certain mental disorders or physical disabilities and with a primary, up to maximally 4–5 cm large, non-recurrent umbilical hernia that will undergo repair in an elective setting. In case of end-stage cardiac and/or pulmonary disease local anesthesia must be considered as the preferred option.

This review has some limitations. Heterogeneity is the main disadvantage of this study. There is no consensus regarding the injection technique or the anesthetic drug that should be used. Postoperative pain, an essential outcome parameter, is not thoroughly described, and no standardized questionnaires were used to measure this outcome parameter. Furthermore, it is not clear if the complications and recurrences described in the included articles, occurred in the patient group we aim to investigate. Finally, we cannot conclude if patients with umbilical hernia treated with local anesthesia have a shorter duration of operation and a shorter duration of stay, since no comparison is made with a control group. Based on our findings, we cannot state that local anesthesia for umbilical hernia patients has any advantages.

## Conclusion

Local anesthesia for umbilical hernia patients seems safe and feasible. However, the advantages of local anesthesia are not sufficiently demonstrated in the current available literature. Almost every outcome parameter is not specified for the patient group we aim to investigate: patients with umbilical hernia treated with local anesthesia. We still do not know if local anesthesia for umbilical hernia gives excellent results, so we cannot implement it in daily practice. Therefore, we propose to initiate a randomized controlled trial, comparing local anesthesia with general anesthesia for patients with umbilical hernia. This could reveal if local anesthesia has any advantages.

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### Compliance with ethical standards

**Conflict of interest** The authors of this manuscript have no conflicts of interest to disclose. AJ declares no conflict of interest. RK declares no conflict of interest. FM declares no conflict of interest. JJ declares no conflict of interest. JL declares no conflict of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Human and animal rights** This article does not contain any studies with animals performed by any of the authors.

**Informed consent** For this type of study formal consent is not required.

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## Appendix 1

### Literature search strategy

#### Pubmed Publisher 15

In PubMed the following search strategy was performed: (((umbilic\*[tiab] OR “abdominal wall”[tiab] OR ventral[tiab]) AND (herni\*[tiab] OR defect\*[tiab])) OR exomphal\*[tiab])) AND (((local[tiab] OR topical[tiab] OR region\*[tiab] OR infiltrat\*[tiab] OR conduct\*[tiab] OR block\*[tiab]) AND (anesthe\*[tiab] OR anaesthe\*[tiab])) OR ((ambula\*[tiab] OR day[tiab] OR daycare[tiab] OR outpatient\*[tiab] OR “short stay”[tiab]) AND (surg\*[tiab] OR setting\*[tiab] OR operati\*[tiab] OR procedure\*[tiab] OR treat\*[tiab] OR therap\*[tiab] OR repair\*[tiab] OR hernioplast\*[tiab] OR herniorrhaph\*[tiab])) OR “day case”[tiab])) AND publisher[sb].

#### Embase 507

In Embase the following search strategy was performed: (‘umbilical hernia’/de OR ‘abdominal wall hernia’/de OR (umbilicus/de AND (hernioplasty/de OR herniorrhaphy/de)) OR (((umbilic\* OR ‘abdominal wall’ OR ventral) NEAR/6 (herni\* OR defect\*)) OR exomphal\*):ab,ti) AND (‘local anesthetic agent’/exp OR ‘local anesthesia’/exp OR

‘ambulatory surgery’/de OR ‘outpatient department’/de OR outpatient/de OR ‘ambulatory care’/de OR ‘anesthetic needle’/de OR (((local OR topical OR region\* OR infiltrat\* OR conduct\* OR block\*) NEAR/3 (anesthe\* OR anaesthe\*)) OR ((ambula\* OR day OR daycare OR outpatient\* OR ‘short stay’) NEAR/3 (surg\* OR setting\* OR operati\* OR procedure\* OR treat\* OR therap\* OR repair\* OR hernioplast\* OR herniorrhaph\*)) OR ‘day case’):ab,ti).

#### Medline 36

In Medline the following search strategy was performed: (“Hernia, Umbilical”/OR “Hernia, Ventral”/OR (umbilicus/AND (herniorrhaphy/)) OR (((umbilic\* OR “abdominal wall” OR ventral) ADJ6 (herni\* OR defect\*)) OR exomphal\*):ab,ti.) AND (“Anesthesia, Local”/OR “Anesthetics, Local”/OR “Ambulatory Surgical Procedures”/OR “outpatients”/OR “Ambulatory Care”/OR (((local OR topical OR region\* OR infiltrat\* OR conduct\* OR block\*) ADJ3 (anesthe\* OR anaesthe\*)) OR ((ambula\* OR day OR daycare OR outpatient\* OR “short stay”) ADJ3 (surg\* OR setting\* OR operati\* OR procedure\* OR treat\* OR therap\* OR repair\* OR hernioplast\* OR herniorrhaph\*)) OR “day case”):ab,ti.).

#### Cochrane 6

In Cochrane the following search strategy was performed: (((umbilic\* OR ‘abdominal wall’ OR ventral) NEAR/6 (herni\* OR defect\*)) OR exomphal\*):ab,ti) AND (((local OR topical OR region\* OR infiltrat\* OR conduct\* OR block\*) NEAR/3 (anesthe\* OR anaesthe\*)) OR ((ambula\* OR day OR daycare OR outpatient\* OR ‘short stay’) NEAR/3 (surg\* OR setting\* OR operati\* OR procedure\* OR treat\* OR therap\* OR repair\* OR hernioplast\* OR herniorrhaph\*)) OR ‘day case’):ab,ti).

#### Web of Science 152

In Web of Science the following search strategy was performed TS = (((umbilic\* OR “abdominal wall” OR ventral) NEAR/6 (herni\* OR defect\*)) OR exomphal\*)) AND (((local OR topical OR region\* OR infiltrat\* OR conduct\* OR block\*) NEAR/3 (anesthe\* OR anaesthe\*)) OR ((ambula\* OR day OR daycare OR outpatient\* OR “short stay”) NEAR/3 (surg\* OR setting\* OR operati\* OR procedure\* OR treat\* OR therap\* OR repair\* OR hernioplast\* OR herniorrhaph\*)) OR “day case”))).

#### Scopus 230

In Scopus the following search strategy was performed TITLE-ABS-KEY((((umbilic\* OR “abdominal wall” OR



ventral) W/6 (herni\* OR defect\*) OR exomphal\*) AND (((local OR topical OR region\* OR infiltrat\* OR conduct\* OR block\*) W/3 (anesthe\* OR anaesthe\*)) OR ((ambula\* OR day OR daycare OR outpatient\* OR “short stay”) W/3 (surg\* OR setting\* OR operati\* OR procedure\* OR treat\* OR therap\* OR repair\* OR hernioplast\* OR herniorrhaph\*)) OR “day case”))).

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